ATLAS

Noise Source

Type 4240

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Description

Purpose of the Instrument.

The Noise Source Type 4240 is a small mechanical-acoustical device which is intended for field calibration of sound measuring instruments and for testing sound amplifying systems, communication equipment etc. It produces a well-defined sound pressure level with a continuous spectrum covering the most important part of the audio frequency range and presenting a practically gaussian amplitude distribution ("white noise"). These features have been given the Noise Source in order to obtain a reference signal having the same characteristics as the signals usually encountered in accoustic measurements (see also Fig. 9). Such a "random" test signal is in many cases to be preferred to single-tone sine wave references, for example for calibration of non-rms rectifying instruments which in general respond differently for gaussian noise and sine signals. The influence of possible peak-clipping or non linearity of the frequency response of the tested equipment are also minimized when wide band random noise is used as check signal.

General Description.

The principle of operation of the Noise Source Type 4240 is shown on Fig. 1. The outer plastic housing comprises two chambers containing about fourteen thousand 1 mm diameter steel balls. The balls can fall from the upper to

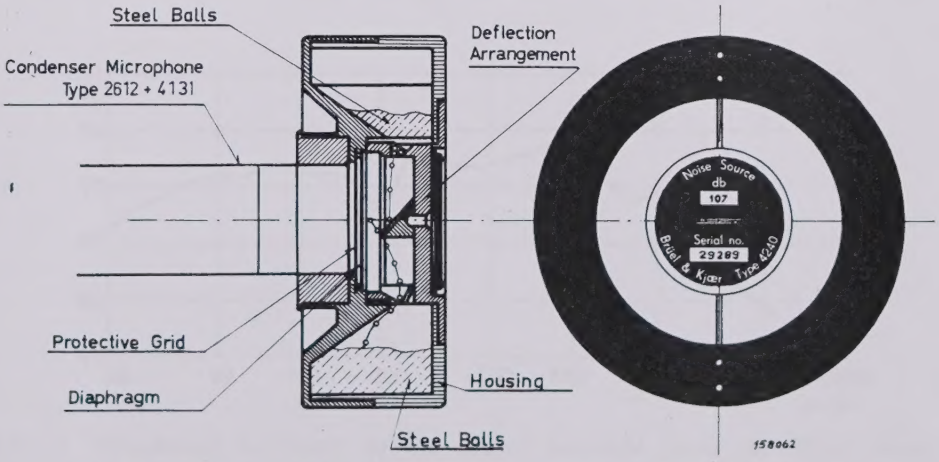

Fig. 1. Section and front view of the Noise Source in operation.

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the lower chamber through appropriate ducts in a similar way as in an hour glass. Approximately 1000 balls per second are thus directed with a constant speed against the diaphragm of the Noise Source, which thereby radiates the required noise with great stability. The process will cease after about 14 seconds, but can be started again by simply turning the housing by 180°.
The Noise Source is designed to fit directly the different B & K condenser microphones, i.e. cylindrical microphones with diameters 36 mm (1.4″), 23.8 mm (0.936″), or 12.7 mm (0.5″) by means of different adaptors supplied with the instrument. These adaptors are designed in such a way that the sound pressure level at the microphone diaphragm is the same whichever B & K microphone is mounted. This sound pressure level, which is of the order of 108 db re. 0.0002 dyne/cm^2, is individually measured on a "true RMS" meter at the factory with an absolute error of less than 1 db and is inscribed on the cover of each Noise Source. Owing to its rugged construction, the Noise Source exhibits excellent stability and can be expected to reproduce the calibration sound level within $\pm$ 1.5 db in ordinary field conditions, when it is correctly fitted on the microphone. The temperature dependency of the calibration is less than 0.5 db from 0°C to 70°C (+32 to +170°F). Atmospheric ambient pressure variations and relative humidity (in the absence of condensation) are without appreciable influence.

Analysis of the Produced Noise.

A frequency analysis of the sound produced by the Noise Source Type 4240 is seen in Fig. 2 as obtained by means of a narrow band continuous analyzer, and in Fig. 6 as measured with a ⅓ octave spectrometer. The spectrum is approximately flat from 50 c/s to 2000 c/s. When dealing with noise, however, not only the frequency analysis but also the amplitude density analysis should be considered. As stated above, the Noise Source features a normal random amplitude distribution, and this is examined in detail in the following.

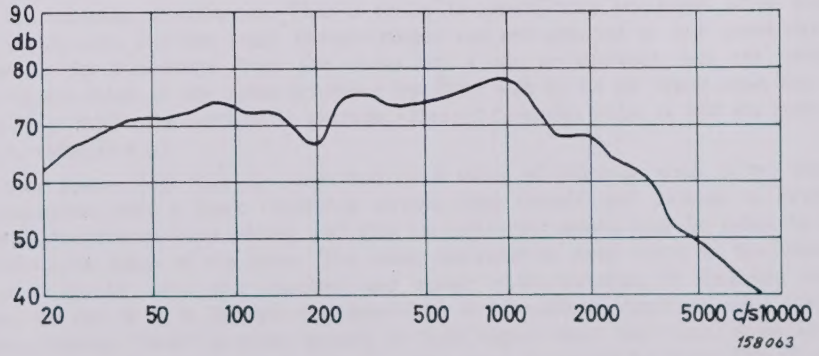


Fig. 2. Frequency spectrum of the sound radiated from the Noise Source Type 4240, when it is tightly fitted onto the measuring microphone, (plotted on spectrum level basis).

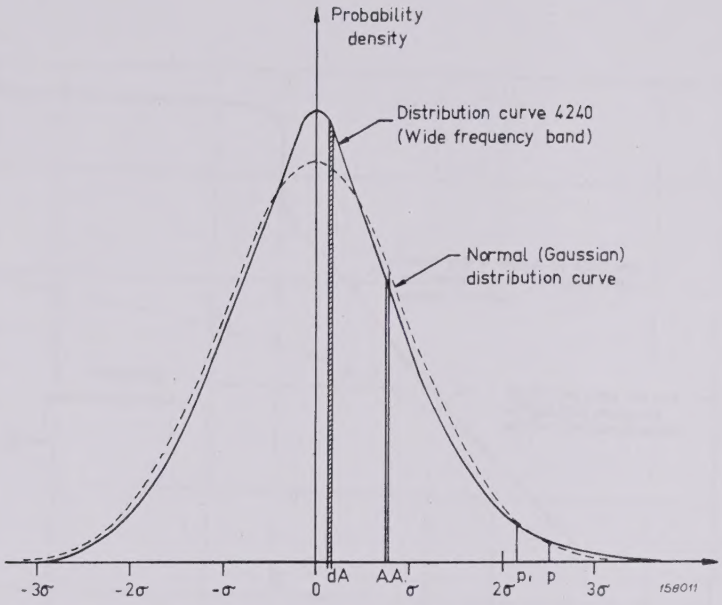
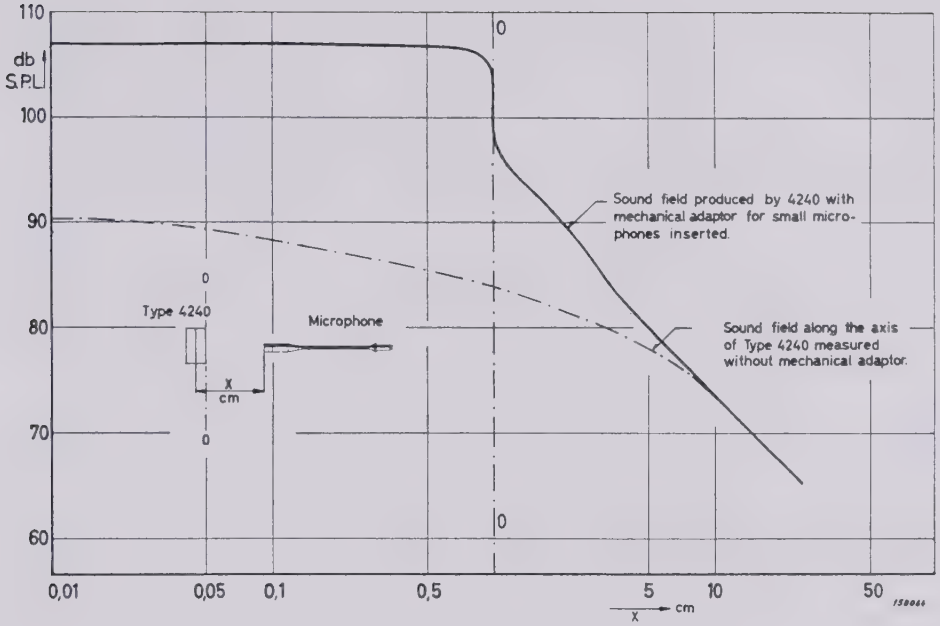


Fig. 4. Statistical distribution of instantaneous sound amplitudes produced by Type 4240.

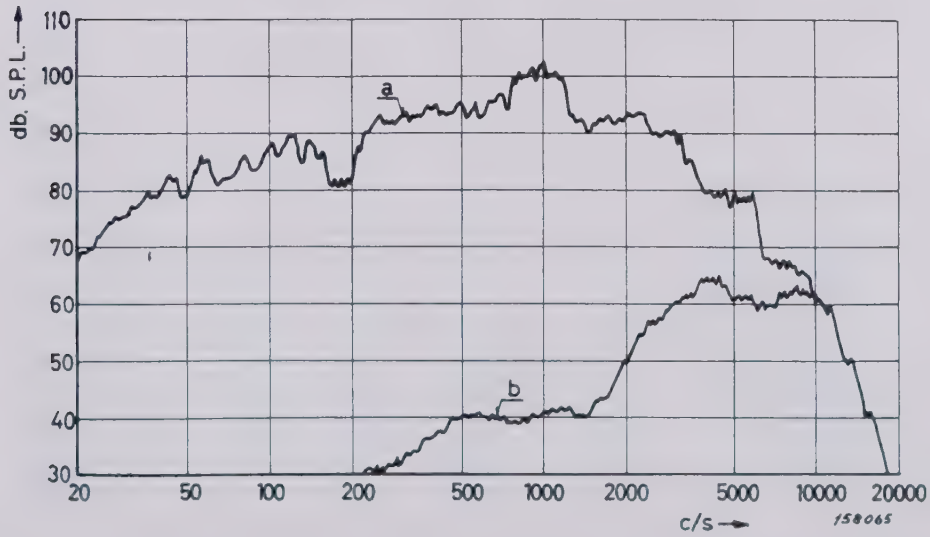
Statistical Amplitude Distribution.

From the principle of operation of the Noise Source it is obvious that the occurance of the instantaneous amplitudes of the produced sound waves will show a statistical rather than a periodical distribution as a function of time. The distribution curve is plotted in fig. 4, together with the normal (Gaussian) distribution curve with the same r.m.s. value (= Standard deviation = σ). It can be seen that the distribution is symmetrical and very close to the normal distribution except for values close to zero where the probability of finding amplitude values within a small (differential) interval dA is greater than in the case of the Gaussian distribution. This is owing to unavoidable transients when the balls hit the diaphragm, but the noise characteristics are not affected to any great extent as explained in the following: From the curve fig. 4 can be deduced that the arithmetic average (A.A.) value of the noise produced by Type 4240 is 2.4 db lower than the r.m.s. value (o.76 σ) while the arithmetic average value of Gaussian noise is 1.96 db lower than the r.m.s. value (o.8 σ).

It is a well known fact that the theretical peak value of Gaussian noise is ∞. However, when measured with a peak rectifying circuit, this circuit will average a number of different instantanuous peak values and give an indication which may be taken to be the "practical" peak value of the noise. The value indicated as peak value on the instrument meter will depend upon the rectifier and meter characteristics. If Gaussian noise is measured on the B & K Microphone Amplifiers or Frequency Analyzer with the meter switch in position "Peak" a value around 6—7 db higher than the r.m.s. value is found. The corresponding "practical peak value" of the noise produced by Type 4240 is approx. 8 db higher than the r.m.s. value. For the sake of convenience these values are also indicated in fig. 4.



ig. 5. Curve indicating the sound pressure level at different distances away from Type 4240.



g. 6. Frequency spectrum of the sound produced by Type 4240 and measured by means of filters with ⅓ octave bandwidths.

a. The Noise Source is placed on the Microphone.

b. The Noise Source is placed a distance of 12 cm away from the microphone.

Operation

CAUTION: Do not allow the Noise Source to become magnetised by strong magnetic fields. Magnetization of the steel balls may be the cause of irregular functioning. Demagnetization can be achieved by means of the decay of an A.C. field.

A. Calibration of Sound Measuring or Recording Systems.

Calibration is normally carried out in closed coupler pressure conditions. The fitting of the Noise Source on the microphone is not critical, but it should be made carefully. By means of two easily interchangeable adaptors supplied, the Noise Source fits directly cylindrical microphones with the following diameters: 36 ± 0.2 mm, 23.8 ± 0.2 mm and 12.7 ± 0.2 mm (B & K microphones). Similar adaptors can be easily made for cylindrically shaped microphones with different diameters (but smaller than 36 mm). In cases where an appropriate adaptor is not available, calibration may still be made with the aid of the sound level-versus-distance curves of Fig. 5, and by taking into account, if necessary, the change in frequency spectrum as shown in Fig. 6.

General Procedure.

(1) Holding the Noise Source in one hand, fit it onto the microphone of the equipment under calibration (Fig. 7). This axis of the microphone should be horizontal and the centre line drawn on the cover of the Noise Source should be held vertical.

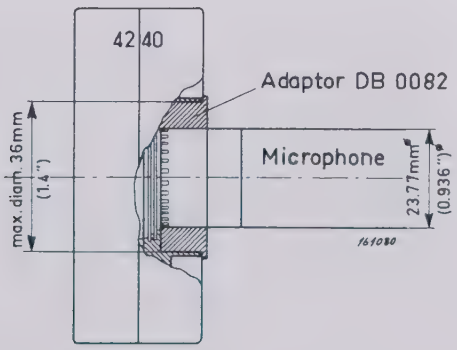


Fig. 7. The Noise Source correctly placed on a "one-inch" diameter microphone.

(2) Turn the plastic housing by 180°. The sound pressure level at the microphone diaphragm has the r.m.s. value inscribed on the cover of the Noise Source. The sensitivity of the measuring equipment should then be adjusted until its indication corresponds to the sound level.

NOTE: When dealing with noise, the indication of a measuring instrument may depend not only on its sensitivity but also on the frequency response and on the rectifying circuit characteristic:

Influence of the frequency response:
In the case of the B & K equipment, the frequency response influence appears for the "one-inch" free-field microphone (Cartridge Type 4131), whose closed coupler frequency response starts falling around 2 kc/s. The total sound level produced by the Noise Source is attenuated by 0.5 to 1 db for this reason.

Influence of the rectifying circuit:
The influence of the rectifier characteristic should be considered when calibrated instruments are not "true r.m.s." rectifying. This is usually the case in instruments provided with a conventional average value bridge rectifier in combination with a meter scale graduated in r.m.s. values of a sine wave. The "form factor"*) of the Noise Source being 2.4 db, instead of 0.9 db for a sine wave, the indication of the instrument is for this reason attenuated by 1.5 db with respect to the indication obtained with a sine wave of equal r.m.s. value. Since the form factor of pure Gaussian noise is 2 db, the instrument can be calibrated in r.m.s. values of Gaussian noise by adding 0.4 db to the Noise Source calibration (0.4 db is often negligible in practice).
The different Brüel & Kjær A.F. measuring instruments are equipped with a "true r.m.s." meter which eliminates the influence of the form factor and of the crest factor (up to 5).

Level Recording Calibration.
When sound level measurements are recorded, the Noise Source will provide direct calibration of the recording paper level scale. The Noise Source's sound pressure level, which is of the order of 108 db, will in most cases lie within the measuring range. If not, use can be made of the attenuators of the instruments and the change of amplification accounted for in the calibration. The above mentioned frequency response and rectifier influences should also be kept in mind when calibrating a recording. In the case of the B & K Level Recorder Type 2305, which is provided with a "true-r.m.s." rectifying circuit, no corrections are to be made. However, when using its predecessor, the

*) Form factor = r.m.s. value / average value.
Crest factor = peak value / r.m.s. value.

Type 2304, which is a peak rectifying instrument (if not modified) a correction should be made, equal to the practical crest factor difference between the measured signal and the calibration signal. The Noise Source's crest factor is around 8 db (2.5) when measurements are carried out with peak rectifying B & K Instruments. Most of the acoustical noises present approximately the same "crest factor", and the Noise Source Type 4240 is therefore very convenient for the calibration of non-r.m.s. rectifying level recorders.

Tape Recording Calibration.

Acoustic measurements in the field are often tape-recorded, in order to allow investigations and analyses to be carried out later on in the laboratory. The Noise Source Type 4240 is also in this case a useful tool which enables the recording of a reference signal to be made at the beginning or at the end of the tape, in the same conditions as the signal to be investigated. Sound pressure level measurements may thus be made when replaying the tape.
The same remarks as for Level Recording Calibration are valuable in the present case. An example of this procedure is illustrated in Fig. 8a and b.

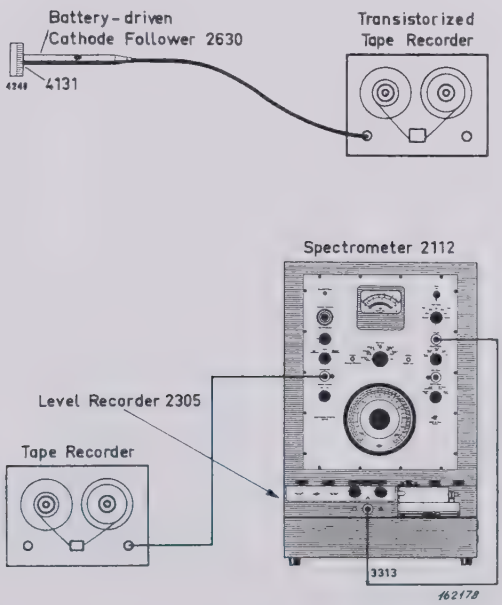


Fig. 8. Calibration of tape recorders for sound measurements.
a) The calibration signal is recorded on the tape.
b) The tape is played back for automatic analysis by means of a B & K Spectrum Recorder.

B. Transmission Checks of Sound Amplifying or Transmitting Systems.

Although the Noise Source is specially designed for calibration checks of sound measuring systems, it may also be useful for checking other electro-acoustic equipment. As outlined above, the characteristics of the acoustic random signal produced by the Noise Source are typical of most natural noises. Even music shows in many cases similar frequency and dynamic distributions. A detailed study of these features will be found in the B & K Technical Review No. 2-1961, whose conclusion is illustrated in Fig. 9. The figure shows clearly that from the dynamic point of view, most natural noises exhibit a somewhat "Gaussian" aspect, while the sine wave deviates markedly from this law.

Therefore when it is intended, for example, to check the functioning of telephone equipment or interphone systems, the Noise Source will provide a suitable "standard" test signal. The advantages of using the Noise Source

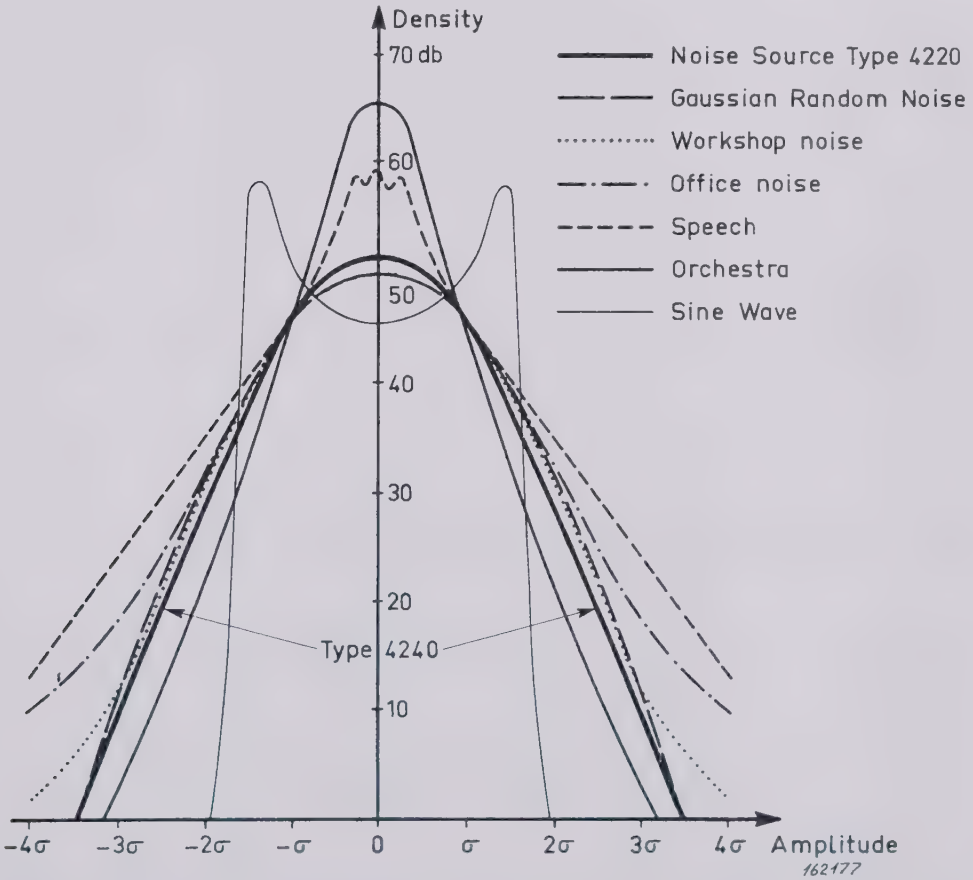


Fig. 9. Comparison of amplitude density curves for the Noise Source Type 4240 and different acoustic signals plotted with logarithmic density scale. (After B & K Technical Review No. 2-1961, p. 13).

instead of, as in common practice, talking or whistling in front of the microphone, are mainly the reliability and comparability of results obtained when checking with a well-defined test signal. These applications are illustrated in Fig. 10.

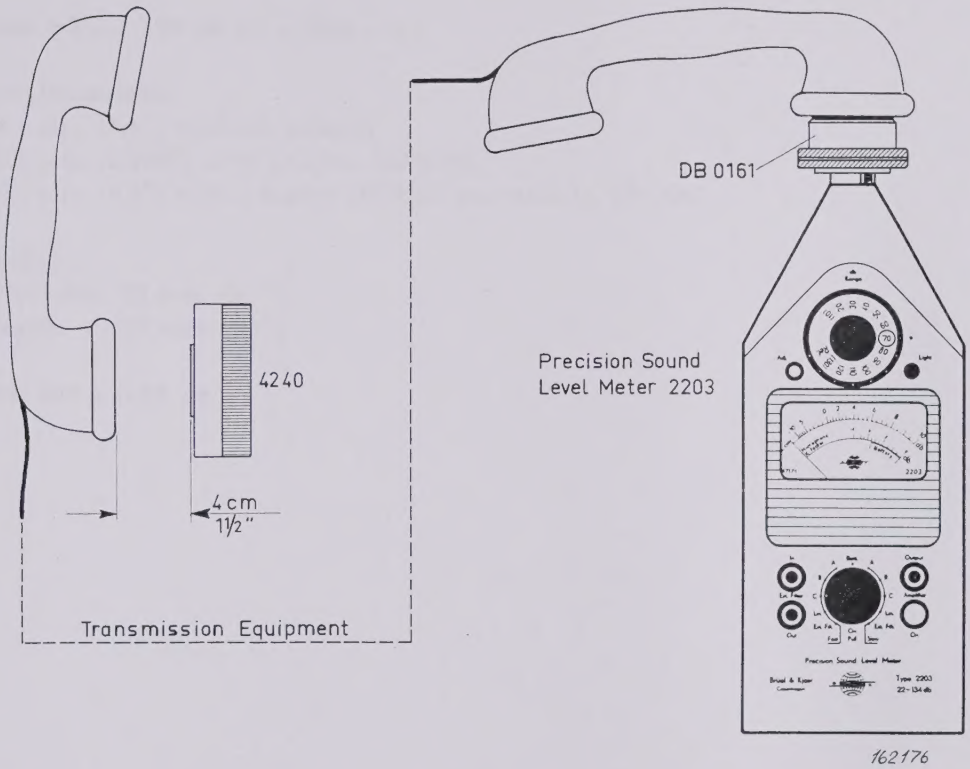


Fig. 10. Wide-band testing of communication equipment. The check can be made selectively in octave bands by adjunction of a Filter Set Type 1613 to the 2203.

Specification

Nominal S.P.L.: 108 db re. o.0002 μbar.

Coupler Diameters:

36 mm (1.4″) without adaptor
23.8 mm (o.936″) with adaptor DB 0082
12.7 mm (o.5″) with adaptor DB 0387 mounted in DB 0082

Dimensions:

Diameter: 80 mm (3.1″)
Depth: 32 mm (1.2″)

Weight: 400 g (14.5 oz.).